11-2017

# BETTER HEALTH THROUGH HORTICULTURE: USING HORTICULTURE TO INFLUENCE BEHAVIOR AND REDUCE STRESS

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By

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THESIS

Submitted to

Northern Michigan University

In partial fulfillment of the requirements

For the degree of

MASTER OF SCIENCE

Office of Graduate Education and Research

December 2017

# ABSTRACT

## BETTER HEALTH THROUGH HORTICULTURE: USING HORTICULTURE TO INFLUENCE BEHAVIOR AND REDUCE STRESS

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Horticultural intervention in the form of gardening workshops connect participants to nature while they nurture another living organism. Horticultural intervention provides opportunities to socialize and engage in a meaningful activity, which have been recognized as helpful in the treatment of common mental health difficulties such as depression and anxiety. There is a lack of experimental studies based on quantitative data that focus on the effects of horticulture on holistic human health. The author evaluated the effects of a horticultural intervention on two separate groups, older adults and college students. The behavioral effects of engaging in gardening activities were evaluated using observational data, attendance records, and surveys collected from older adult residents of a long-term care facility. The biological effects of engaging in horticulture activities were evaluated using physiological data collected from student participants on a college campus. As a result of the horticultural intervention, greenhouse attendance increased at a long-term care facility and feelings of distress, irritability, and nervousness decreased significantly for participants who attended the workshops regularly. Additionally, physiological data collected from college students suggest lowered blood pressure after engaging in gardening activities. This study presents quantitative evidence regarding the positive behavioral and physical effects of gardening on holistic human health.

ACKNOWLEDGMENTS

This thesis follows the format prescribed by the *APA Style Manual* and the Department of Biology at Northern Michigan University. The author wishes to thank the following individuals whose cooperation made this study possible: student observers for their assistance in data collection - Scott Conger, Kristen Gonzalez, Mackenzie Houseman, and Nicole Ketola; student greenhouse aids - Danielle Fawaz, Jenna Happach, Mindy Kantola, and Tabitha McAlpine; the long-term care facility's administration, staff and those who participated in the study; student technicians from the department of surgical technology- Alexandria Rich and Morganne Crable; Transition Marquette County for seed, soil, and supply donations. The comments of Dr. Donna Becker, Dr. Jacob Daar, Dr. Paul Andronis, Dr. Alan Rebertus, Steve Finley, and Richard Lopez were gratefully acknowledged throughout the duration of the project. Finally, the author wishes to thank Drs. Daniel and Sheila Ochylski and James Sheff for their extensive advice and support. Without the help of these extraordinary people, this project could not have been completed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# INTRODUCTION

The World Health Organization defines human health as a state of complete physical, mental and social well-being and not merely the absence of disease (WHO, 1948). This definition implies that to fully understand the concept of health a wide array of associated factors should be considered including psychological, social, biological, and physiological. Epidemiological studies have provided evidence of a positive relationship between longevity and access to green space (Takano et al., 2002, Tanaka et al., 1996), and between green space and self-reported health (de Vries et al., 2003).

Depression is the most common cause of morbidity and decreased quality of life in the U.S. aging population (Thakur and Blazer, 2008). Beyond personal suffering and family disruption, depression worsens the outcomes of many medical disorders and promotes disability (Alexopoulos, 2005). Military veterans living in a long-term care facility may experience depression as a result of bereavement, disability, chronic medical illness, and cognitive impairment. In 2016, over one-third of U.S. college students had difficulty functioning due to depression, and over half reported feelings of overwhelming anxiety in the last year (NCHA, 2016). Stressors affecting college students can be categorized as academic, financial, time or health-related, and self-imposed (Misra and McKean, 2000). Horticultural intervention provides opportunities to socialize, engage in a meaningful activity, and exercise, which have been recognized as helpful in the treatment of common mental health difficulties such as depression and anxiety (Diamant and Waterhouse, 2010, Dunn and Jewell, 2010). Reported benefits of horticultural intervention include: improved health, reduced levels of stress, increased social and cultural integration, and increased self-esteem, sense of community, accomplishment, and pride (Lewis, 1996, Armstrong, 2000).

According to the American Horticultural Therapy Association, "Horticultural therapy is the participation in horticultural activities facilitated by registered horticultural therapists to achieve specific goals within an established treatment, rehabilitation, or vocational plan. Horticultural therapy is an active process which occurs in the context of an established treatment plan where the process itself is considered the therapeutic activity rather than the end product." (AHTA, 2017., para. 3). Legitimate horticultural therapy programs are professionally operated by a registered therapist and represent an organized extension of nature contact familiar to the typical gardener (Selhub and Logan, 2014). There is a lack of experimental and randomly controlled studies based on quantitative data that focus on the effects of horticultural intervention on holistic human health. The present paper reports on changes in behavior, emotional affect, and physiological measures after engagement in a series of horticultural workshops. The study suggests that horticultural intervention reduces stress and promotes social interaction.

## Literature Review

### Horticulture as Therapy

Historically, the use of gardens for reasons other than agriculture dates back as far as 2000 BC in Mesopotamia (Detweiler et al., 2012). The ancient Egyptians planted gardens for aesthetic beauty, privacy, and protection from the elements. Records indicate that there was, and still is, a unique form of pleasure associated with gardening (Kemp, 2006, Turner, 2005). In the 14th century, Irish monks offered solace for 'distressed souls' through gardening activities (McLean, 2014). By the mid-1800s, physicians often promoted gardening as a mental relaxant and this was thought to limit the need for frequent medical consultations. Throughout the 18th century, gardens became a common fixture in mental health institutions. The utility of gardening as a form of adjunctive therapy for shell-shocked soldiers (an early name for modern post-traumatic stress disorder) established the profession of horticultural therapy. By 1929, "horticultural therapist for hospitals" was officially listed as a vocation as one approach to meeting the enormous demand for mental health care services among military personnel. In the decades following World War II, psychologists and other mental-health advocates continued to discuss the benefits of horticultural therapy and to encourage its expansion into more broad avenues of mental health care (Selhub and Logan, 2014).

The majority of the evidence supporting horticulture as therapy was anecdotal and theoretical until the late 20th century. The biophilia hypothesis put forth by E.O. Wilson (1984) asserts the existence of a fundamental, genetically based, human need and propensity to affiliate with life and lifelike processes. Additionally, Kahn (1997) describes the biophilia hypothesis as "a valuable interdisciplinary framework for investigating the human affiliation with nature". Recent studies have explored the effects of human's affiliation with nature, suggesting that even minimal connection, such as looking through a window, increases productivity and health in the workplace, promotes healing of patients in hospitals, and reduces the frequency of sickness in prisons (Kahn, 1997). Using the biophilia hypothesis as a framework, two psycho-evolutionary theories emerged: attention restoration theory (Kaplan and Kaplan, 1989, Kaplan, 1995) and the psychophysiological stress reduction theory (Ulrich et al., 1991). Each theory addresses mechanisms for how contact with natural environments may impact immediate well-being (Clatworthy et al., 2013). Horticultural interventions, however, offer more than simply contact with nature. Horticultural interventions have the potential to positively impact mental, physical, and social wellbeing (Abraham et al., 2010). Holistic interventions such as gardening workshops should be considered for implementation within institutions such as long-term care facilities and education centers.

**Green Space Atmosphere**

**Air pollution and volatile organic compounds.** The reduction of airborne pollutants is likely to have a positive impact on psychological and biological health. Jacobs et al., (1984) presented a relationship between symptoms of depression and air quality in Los Angeles; this effect was heightened in individuals who had recently experienced an undesirable life event such as bereavement, even when potentially confounding factors such as socioeconomic status and prior psychological condition were controlled for. Volatile organic compounds (VOCs) are a major air contaminant in indoor environments and can cause adverse health effects. Exposure to high concentrations can lead to consequences such as reduced awareness and performance, while chronic exposure can result in the onset of asthma and heart disease (Bernstein et al., 2008). Some indoor VOCs are toxic at high levels and some, such as benzene and formaldehyde, have been shown to be carcinogenic (Godish, 2001, IARC, 2006, ATSDR, 2007, Nielsen & Wolkoff, 2010). People are exposed to environmental formaldehyde from wood-based products, wall coverings, rubber, paint, adhesives, lubricants, cosmetics, electronic equipment, and combustion (Zhang et al., 2009, Salthammer et al., 2010). Exposure to high levels may cause throat spasms and accumulation of fluid in the lungs. Repeated exposures can lead to respiratory problems such as asthma and bronchitis (ASTDR, 2015). People are exposed to environmental benzene from gasoline and cigarette emissions, and it is present in common household products such as glue, cleaning products, and paint strippers (Weisel, 2010). Environmental benzene has been referred to throughout the literature as a ubiquitous pollutant (Wallace, 1989, Mafferi et al., 2005) and severe adverse health effects have occurred in occupationally exposed workers. It is clearly established and accepted that benzene exposure can cause acute non-lymphocytic leukemia and a variety of other blood related disorders in humans (US EPA, 2007). Plants have been used to uptake air pollutants via their stomata during normal gas exchange (Schmitz et al., 2000) and various pollutants have been shown to be degraded in situ or after transfer to other areas of the plant. The rhizosphere is the immediate area of soil surrounding the root system, and is directly influenced by root secretions. The rhizosphere represents a unique environment for interactions between roots and large populations of soil microbes and invertebrates (Hirsch et al., 2003).

Evidence indicates that the plants' rhizospheric community is responsible for the majority of the VOC removal from the environment (Wood et al., 2002, Orwell et al., 2004, Kim et al., 2008). Research conducted by NASA suggests common houseplants and their associated microorganisms can be used to reduce indoor air pollution in closed, occupied systems in outer space. The Areca Palm (*Chrysalidocarpus lutescens*), Mother-in law's Tongue (*Sansevieria trifasciata* var. *laurentii*), Green Spider Plant (*Chlorophytum elatum*), Golden Pothos (*Scindapsus aureus*), the Money Plant (*Epipremnum aureum*) and many others have been used to observe the ability of plants and their associated soil microorganisms to remove VOCs from the environment and maintain a safe and healthy personal breathing zone (Wolverton & Wolverton, 1993). Results from additional studies show that plants have effectively reduced levels of benzene, ammonia, formaldehyde, nitrogen oxides and particulate matter (Godish & Guidon, 1989, Wolverton & Wolverton, 1993, Giese et al., 1994, Lohr et al., 1996).

**Microbiota and Soil Bacteria.** Microbiota are now widely accepted as important for human host development and for continued immune homeostasis. The microbiota aid in the digestion of food and nutrient absorption, protect against colonization by pathogens and profoundly affect the induction of immune functioning (Frei et al., 2012). Multiple studies have demonstrated that early-life exposures to microorganisms in the environment afford protection against allergic disease and asthma later in life (Kozyrskyi et al., 2011, Araujo et al., 2004, von Mutius, 2000, Debarry, 2007, Ege et al., 2006, Roduit et al., 2011). Researchers suggest that treatment with a specific soil bacterium, *Mycobacterium vaccae,* may alleviate depression. Lung cancer patients who were injected with killed *M. vaccae* reported improved quality of life and reductions in nausea and pain (O'brien et al., 2004). This bacteria species, when injected into mice, activated a set of serotonin-releasing neurons and altered emotional behavior (Lowry et al., 2007). Weich et al., (2006) found mental health problems were significantly lower in rural areas, where inhabitants are more likely to come in contact with *M. vaccae*. Some researchers suggest that the absence of *M. vaccae* from our everyday lives may help explain why conditions such as asthma and allergies are increasing (Kozyrskyi et al., 2011).

**Nature Views.** Passive viewing of natural environments has been observed to produce stress-ameliorating effects which may ultimately produce health benefits (Ulrich, 1984). A ten-minute video exposure to a nature view (dominated by trees, vegetation or water) after exposure to a stressor video, produced significant recovery from stress within 4-7 minutes. This was indicated by lowered blood pressure, decreased muscle tension, and decreased skin conductance (Ulrich et al., 1991). Moore (1981) observed the impacts of passive nature views on prisoners' self-reported health and found that prisoners assigned to cells without a view of the outdoors had a 24% higher frequency of sick-call visits, compared to those in the exterior cells with a view. Employees with views of nature at work report fewer headaches, less job pressure, and greater job satisfaction than those without a view (Kaplan, 1992). Similar observations have been recorded in healthcare settings. Patients with views of trees had statistically significant shorter hospitalizations and less need for pain medications compared to patients with views of a brick wall (Ulrich et al., 1984). Nearby foliage visible from apartment buildings has been shown to enhance residents' effectiveness in facing major life issues and to lessen intra-family aggression by reducing mental fatigue (Kuo & Sullivan, 2001). Moreover, Kuo and Sullivan observed a correlation between green space and number of reported crimes within an urban area and concluded that the greener a building's surroundings were, the fewer crimes were reported.

**Horticulture and Special Populations.**

**Dementia and PTSD.** Horticultural therapy could be utilized to improve the quality of life of the worldwide aging population, possibly reducing costs for long-term care for persons living in assisted living facilities and residents of dementia units (Detweiler et al., 2012). Preliminary studies have reported the benefits of horticultural therapy and garden settings in the reduction of pain, improvement in attention, lessening of stress, modulation of agitation, lowering of as needed medications, and reduction of falls (Detweiler et al., 2012, Rodiek, 2002). Moreover, horticultural therapy has been found to increase feelings of calm and relaxation (Relf,

1992) and has been shown to foster a sense of accomplishment and improved self-esteem (Moore, 1989).

Dementia is a chronic condition that results in a progressive decline in a person's ability to think, remember and reason (WHO, 2012). There has been growing understanding in the healthcare sector about the importance of the healing environment. The current research suggests that gardens can specifically improve the health of people with dementia in a number of ways from encouraging cardiovascular exercise, stimulating the appetite and increasing vitamin D levels, to improving mood, relieving stress and providing an activity to share with family and caretakers (Ulrich et al., 1991, Pugh, 2013).

A survey conducted by the American Psychiatric Association found that about one-third of soldiers previously deployed to Iraq and Afghanistan have reported symptoms of traumatic brain injuries, post-traumatic stress disorder, and/or major depression. Limited data suggest that therapeutic gardens have a positive effect on veterans suffering from emotional trauma (Wagenfield et al., 2013). Persons affected by the above may benefit from horticultural intervention because the greenhouse environment is a low stimulus setting with sunlight, fresh air, and high humidity and oxygen contents.

**Stress and Depression.** Exposure to chronic stress increases vulnerability to adverse medical outcomes (Miller et al., 2007). This vulnerability holds true across a wide variety of mental and physical conditions. For example, people facing chronic stress are more likely to develop clinical depression, experience symptoms of an upper respiratory infection following viral exposure, suffer from a flare-up of an existing allergic or autoimmune condition, and show accelerated progression of chronic diseases such as acquired immunodeficiency syndrome and coronary heart disease (Miller et al., 2002, Monroe and Hadjiyannakis, 2002, Pereira and

Penedo, 2005, Rozanski et al., 1999, Wright et al., 1998). This phenomenon is apparent across the lifespan. From early in childhood to late in adulthood, chronic stress is accompanied by an increased risk of health problems such as depression, heart disease and weight gain (Coe and Lubach, 2003, Kiecolt-Glaser and Glaser, 2001, Repetti et al., 2002, Taylor et al., 1997), and the magnitude of this effect is substantial. In some cases, exposure to chronic stress triples or quadruples the chances of an adverse medical outcome (Cohen et al., 1998, Sandberg et al., 2004). Biochemical indices of stress include increased levels of adrenaline, cortisone, epinephrine, and norepinephrine, which have been shown to be reactive to psychological stress (Forsman and Lundberg, 1982, Vaernes et al., 1982, Ward et al., 1983). Hypertension is traditionally defined as a persistent systolic blood pressure of at least 140 mm Hg and/or diastolic blood pressure of at least 90 mm Hg (Fields et al., 2004). Stress is generally thought to contribute to the development of hypertension. Hypertension affects over 65 million people, about 29% of the adult population in the United States (Hajjar and Kotchen, 2003, Fields et al., 2004). Depression is often present in hypertensive patients and has been associated with increased mortality risk (Axon et al., 2010). Hypertension and symptoms of depression are risk factors for cardiovascular disease (Ayada et al., 2015). Psychogenic fever is a stress-related, psychosomatic disease. Some patients develop extremely high core body temperature when they are exposed to emotional events or situations of chronic stress (Oka, 2015). Suess et al., (1980) explored the relationship between hyperventilation and anxiety and found that when participants undergo stressful events, respiration rate increases.

Many studies suggest that people use environmental resources for physical activity as part of their strategy for improving mental health (Faulkner and Layzell, 2000). There has been a substantial amount of research that argues that natural areas are actively pursued by people in order to restore themselves from the stresses of everyday life (Mace et al., 1999). A review by Mace et al., (1999) provides evidence that natural environments play an important role in facilitating recovery from stress, and found that stress reduction consistently emerges as the key perceived benefit of a wilderness experience (Knopf, 1987, Ulrich et al., 1991). Van den Berg and Custers (2011) assessed cortisol levels of participants after undergoing a stressful Stroop task, then randomly assigned them to 30 minutes of gardening or reading. Both gardening and reading resulted in decreased cortisol levels; however, decreases were significantly stronger in the gardening group. Thompson et al., (2012) present evidence connecting green spaces in deprived communities to lower stress levels using salivary cortisol patterns, supporting previous experimental evidence that natural environments may be associated with stress reduction.

**Literature Review Conclusions**

Although the previously mentioned studies provide examples of benefits from interacting with plants in green spaces, Sempik et al., (2003) concluded that most of the research regarding horticultural intervention is purely descriptive and contains little quantitative data. A comprehensive literature review conducted in 2012 calls for further research on the topic of horticultural therapy and therapeutic greenhouses, "Initiating studies regarding the use of therapeutic gardens and/or therapeutic greenhouses may increase the evidence to sustain or refute the benefits of garden settings" (Detweiler et al., 2012). Social and physical benefits of participation in gardening activities such as increased social integration and reduced levels of stress have been reported (Armstrong, 2000). Clatworthy et al., (2013) posit that zero studies evaluating the benefits of gardening-based interventions for adults including objective validated outcome measures to explore the impact of a gardening-based intervention exist. Furthermore, there seems to be a paucity of published quantitative experimental studies and randomly controlled trials.

This study aimed to quantitatively evaluate the effects of a horticultural intervention on two populations, older adults and college students. These populations may benefit from the social, psychological, and physiological effects of engagement in a gardening workshop series. Both projects involved data collection before and after engaging the experimental group in activities within green spaces. A single-subject and within-subjects ABABA withdrawal design (Kazdin, 2011) was applied and behavioral measures were collected at a long-term care facility for older adults. The experimental group (n=11) received horticultural intervention by engaging in gardening activities for about 2 hours each week for 12 weeks. Attendance records, behavioral measures, and Positive and Negative Affect Scale (PANAS) (Watson et al., 1988) scores were used to evaluate the effects of gardening activities. In a second study, a pre-post assessment was applied and physiological measures were collected by trained technicians at Northern Michigan University. The experimental group (n=5) received horticultural intervention by engaging in gardening activities for 30 minutes each week for a 4 week period. Behavioral data were analyzed utilizing visual inspection and a linear mixed model. Physiological data were analyzed utilizing visual inspection and a paired t-test.

# METHODS

**Using Horticulture to Influence Behavior in Older Adults.**

***Design***. The research group employed a single-subject and within single-group design over a 12 week period. The study utilized an ABABA withdrawal design with seven phases, the A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

***Participants***. Eleven elderly adults aged 60 or older, were recruited to participate in an experimental study. The participants (3 women, 8 men) ranged in age from 64 to 96 years (mean=80.6, SD=10.8) and were all military veterans or spouses of veterans. All participants were Caucasian and residents of a long-term care facility located in northern Michigan.

***Materials***. An attendance log was used to monitor participants' attendance in the greenhouse and in the recreation room during a designated social hour. A partial time sampling recording method was utilized by the primary investigator and a trained secondary observer during the social hour organized by the staff at the home. A secondary observer collected reliability data during 75% of the observation periods during phase 1 and 48% of the observation periods during phase 2. The average interobserver agreement was 84.2% (range, 43.3%-100%).

The Positive and Negative affect scale (PANAS) was used to evaluate participant's emotional affect before and after engaging in gardening workshops (Figure 26). Participants were asked to complete a 20-item test using a 5-point scale that ranged from very slightly or not at all (1) to extremely (5). The PANAS has strong reported validity with such measures as general distress and dysfunction, anxiety, and depression (Crawford & Henery, 2004).

***Procedure***. This project aimed to evaluate the effects of a horticultural intervention on social hour attendance, on the frequency of positive social interactions that occurred during the social hour, and on PANAS scores. The research team observed each participant during a social time of day and recorded the frequency of positive social interactions using a paper and pencil 30-s partial interval recording system. The partial interval recording system used in the collection of behavioral data required observers to record the occurrence or nonoccurrence of positive social behavior every other period of 30 seconds for 30 minutes. The frequency of individual positive social interactions was calculated by dividing the intervals in which any positive social interactions were observed by the total number of intervals each participant attended the social hour. The mean of individual positive social interactions was calculated by multiplying the average of intervals in which positive social interaction had occurred by the average frequency of positive social interactions within each phase. Positive social behaviors were defined as any behavior that tries to affect or take into account another person's subjective experiences with positive intentions. The most common positive social behaviors observed among participants were talking, smiling, laughing, and nodding in agreement. Because we were interested in changes in participants' attendance, PANAS score, and engagement in social behavior, the participants served as their own controls. Horticultural intervention served as the independent variable, while social hour attendance, the amount of positive social interactions observed, and PANAS scores were the dependent variables. Baseline data regarding each participant's attendance and the number of observable social interactions that occurred during the social hour were collected during the first week of the study. The experimental group (n=11) received horticultural intervention by engaging in gardening activities for at least 30 minutes each day for 10 days.

***Research Setting.*** Data collection took place in a recreation room within a long-term care facility. The room was open to residents of the wing in which it was located and housed amenities such as TVs, books, magazines, lounge chairs, dining tables, and a small kitchenette. The staff organized a coffee social hour during weekday mornings from 9:00 AM-10:00 AM, during which participant's attendance and frequency of social interactions were observed. During the coffee hour, staff members facilitated conversation between the residents while serving coffee and cookies. Occasionally, activities such as painting and yoga classes took place in the recreation room. Some participants visited with family in the recreation room during the observation period.

The horticultural intervention took place in the 450 square foot greenhouse attached to the home (Figure 28). The greenhouse was void of plants and rarely used before the workshops began. Inside the greenhouse, there were metal chairs and wheelchair accessible tables. Once the workshops began, the greenhouse accommodated a wide variety of plants such as ornamental houseplants, fruits, vegetables, herbs, and succulents (Table 2). Outside and parallel to the greenhouse, were three raised garden beds and two wheelchair accessible garden beds (Figure 28).

***Intervention.*** Horticultural intervention took place from April 10 - 19, May 8 – 18, and June 16-June 28. The workshops series included: building soil, identifying seeds, planting seeds, identifying seedlings, plant propagation, a transplanting activity, a miniature garden activity, flower arranging, craft activities using herbs and flowers, herb identification, and preparing a meal using ingredients from the garden. Soil building workshops focused on generating arable soil and involved three steps, mix, blend, and fill. Participants were introduced to components of healthy soil including peat moss, worm castings, and organic fertilizer. Plant propagation workshops involved taking clippings from one plant and repotting them to grow roots and develop into a new plant. During the miniature garden activities, each participant designed a container garden using a small tray and various succulents. At the end of the workshop series, the participants aided in the preparation of a meal that included ingredients from the greenhouse and ate together. Towards the end of the project, many participants requested the workshops be offered during the evening, due to schedule conflicts and a lack of evening activities offered by the home. The primary investigator began offering evening workshops on June 16th. Phase 1 data collection occurred from April 1st 2017 until May 26th 2017 and the experimental group included participants A, B, C, and D only. Phase 2 data collection occurred from May 27th 2017 until July 11th and was initially intended to include an entirely new group of participants (E-K). When phase 1 ended, the participants included in the first group expressed interest in continuing participation in the study, therefore phase 2 data collection occurred from May 27th until July 12th and included participants A, B, C, D, E, F, G, H, I, J, K and L. During phase 2, five residents who were not recruited to participate in the study attended every evening workshop that was offered.

# METHODS

## Using Horticulture to Lower Stress in College Students.

***Design.*** The research group employed a pre-post quasi-experimental design over a four-week period.

***Participants.*** Five college students were recruited to participate in a quasi-experimental study. The participants ranged in age from 18 to 28 years of age (mean=22.6, SD=3.70). All participants were female and attended Northern Michigan University located in Marquette, Michigan.

***Procedure.*** Student technicians from the surgical technology program performed vital signs tests (temperature, pulse, respiratory rate, blood pressure, and pain) on participants before and after engagement in the experimental conditions once a week for four consecutive weeks. Horticultural intervention served as the independent variable, whereas each participant's vital signs data served as the dependent variable. Participants in the experimental group engaged in gardening activities that involved physical contact with plants and/or soil for 30 minutes. The gardening activities included: building soil, identifying seeds, planting seeds, plant identification, plant propagation, a transplanting activity, and plant maintenance. Soil building workshops focused on generating arable soil and involved three steps, mix, blend, and fill. Participants were introduced to components of healthy soil including peat moss, worm castings, and organic fertilizer. Plant propagation workshops involved taking clippings from one plant and repotting them to grow roots and develop into new plants. Plant maintenance workshops involved identifying and removing pests on the plants.

***Materials.*** Technicians used thermometers, blood pressure cuffs, and 3M Littman stethoscopes to collect participant's vital signs data before and after participant's engagement in the experimental condition. Finally, participants were asked to identify their current level of pain on a 1-10 scale.

***Research Setting.*** Data collection took place in a laboratory next to the greenhouse. The experimental group received horticultural intervention inside the University's 908 square foot greenhouse. The greenhouse contained about 150 diverse ornamental plants.

**Using Horticulture to Influence Behavior in Older Adults**

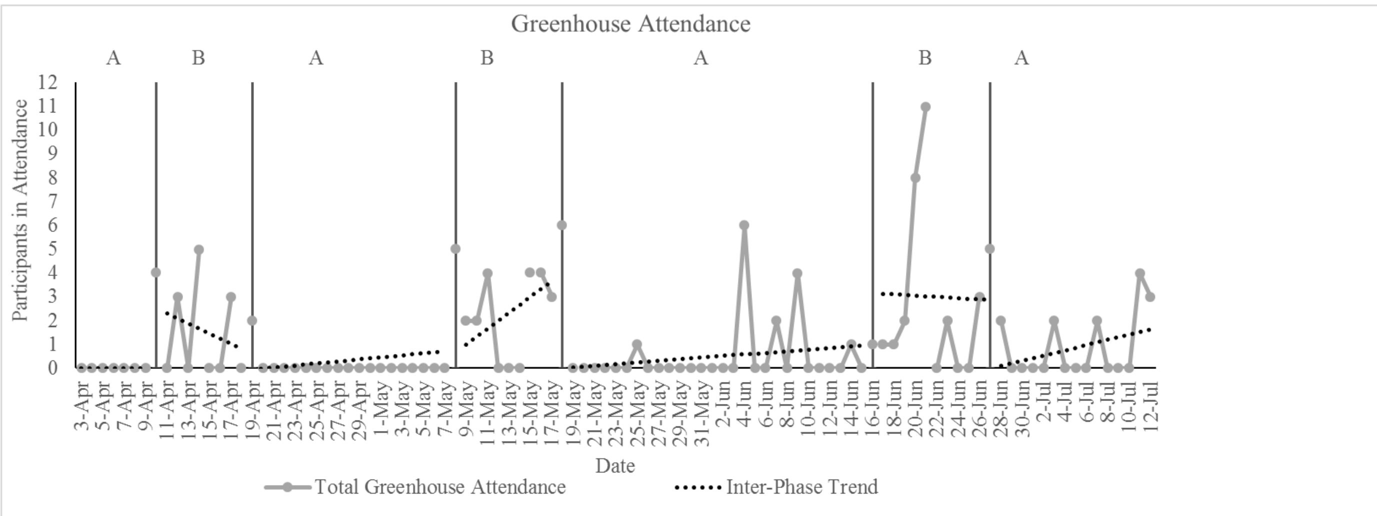



Figure 1. Daily greenhouse attendance before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

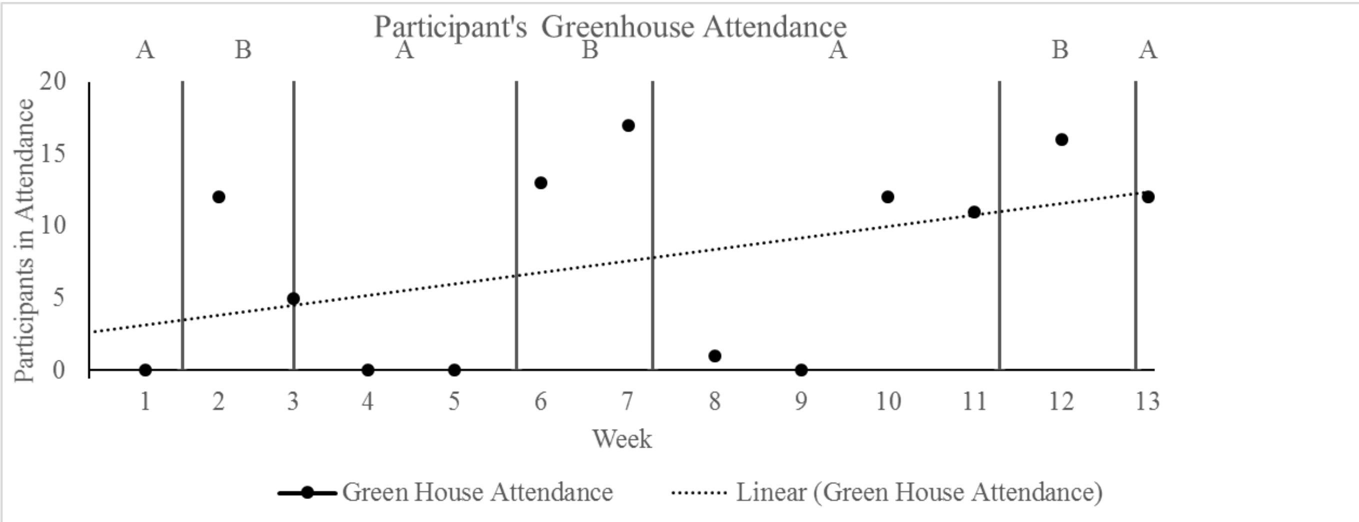



Figure 2. Weekly greenhouse attendance before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

Across each phase, the mean greenhouse attendance changed from baseline to intervention. Greenhouse attendance data was recorded by the primary investigator and recreational therapy staff each week. Before the workshops began, zero participants visited the greenhouse. Following implementation of gardening workshops, greenhouse attendance was observed to be on a variable increasing trend (Figure 1). During the first intervention period, seventeen residents signed in to the attendance log within the greenhouse. Throughout the second baseline condition, zero residents visited the greenhouse. During the second intervention period, thirty participants visited the greenhouse. For the duration of the third baseline condition, fourteen residents visited the greenhouse when gardening workshops were not offered. During the following intervention period, participants signed in to the greenhouse 16 times. Throughout the final baseline phase, twelve residents attended the greenhouse. Implementation of gardening workshops increased greenhouse attendance. The percentage of non-overlapping data points is equal to 21.95% when comparing the first two baseline conditions to the first two intervention phases. The percentage of non-overlapping data decreased to 6.25% when comparing the last baseline condition to the final intervention phase.

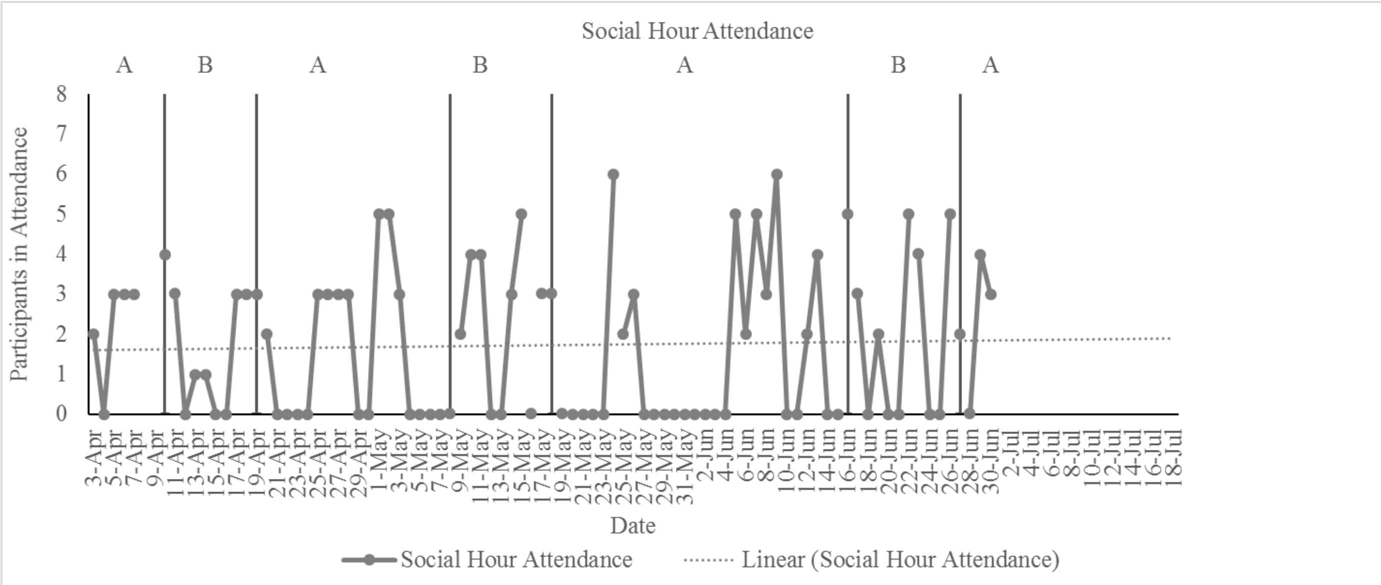



Figure 3. Daily Social Hour attendance before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

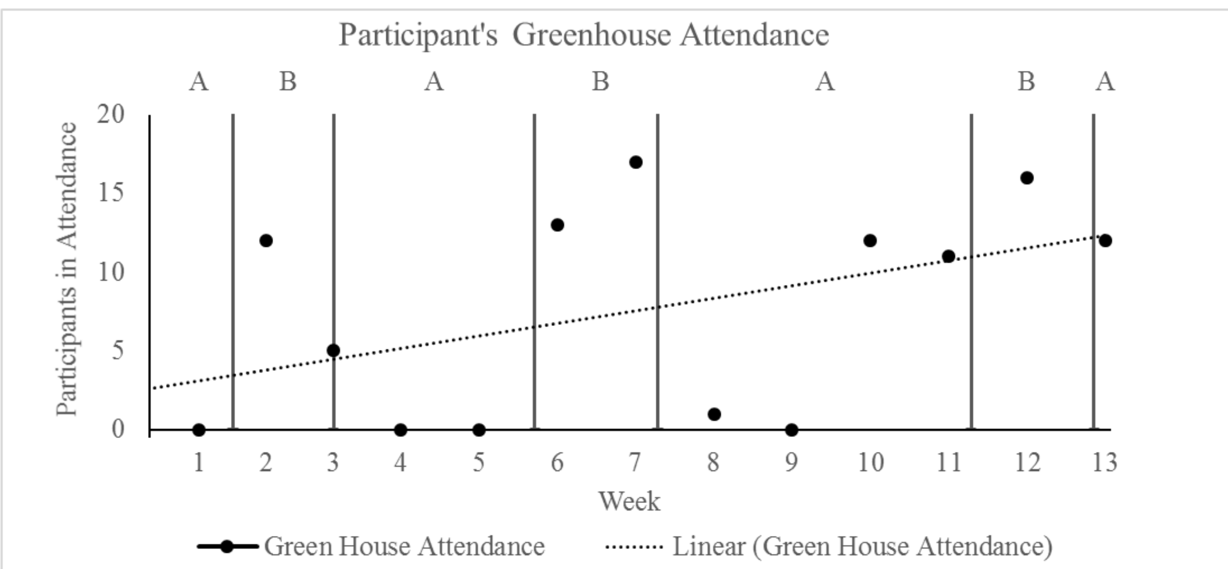



Figure 4. Weekly Social Hour attendance before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was

in place and the B represents the intervention period, during which participants engaged in gardening workshops.

Following implementation of gardening workshops, total social hour attendance was observed to be on a variable increasing trend. Social hour attendance data was recorded by the primary investigator once every week day for a 13 week period. The mean social hour attendance remained consistent during the first two phases and increased during the last four phases. The percentage of non-overlapping data points is equal to 19.35% when comparing the first two baseline conditions to the first two intervention phases in Figure 3. The percentage of non-overlapping data increased to 33% when comparing the last baseline condition to the final intervention phase.

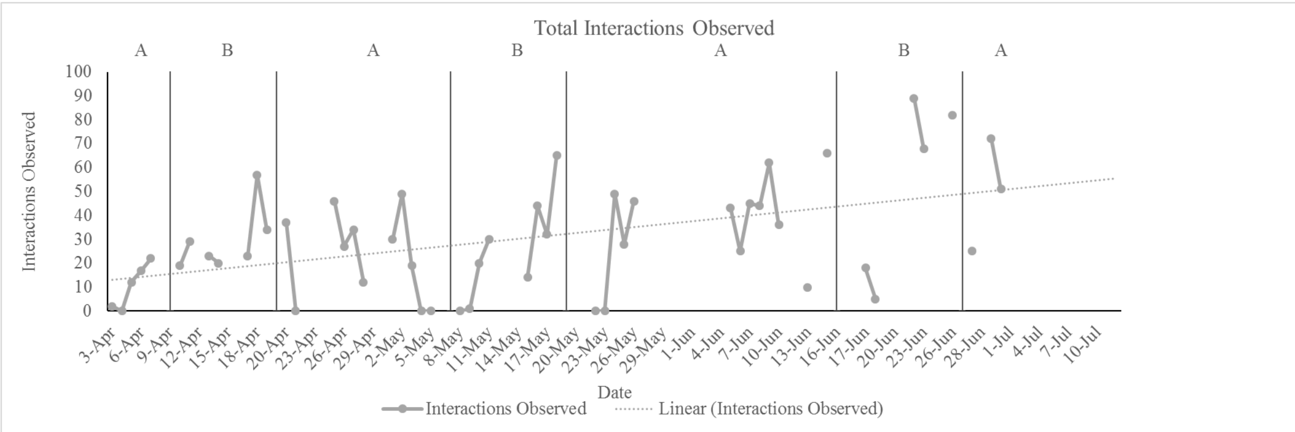



Figure 5. Daily positive social interactions observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

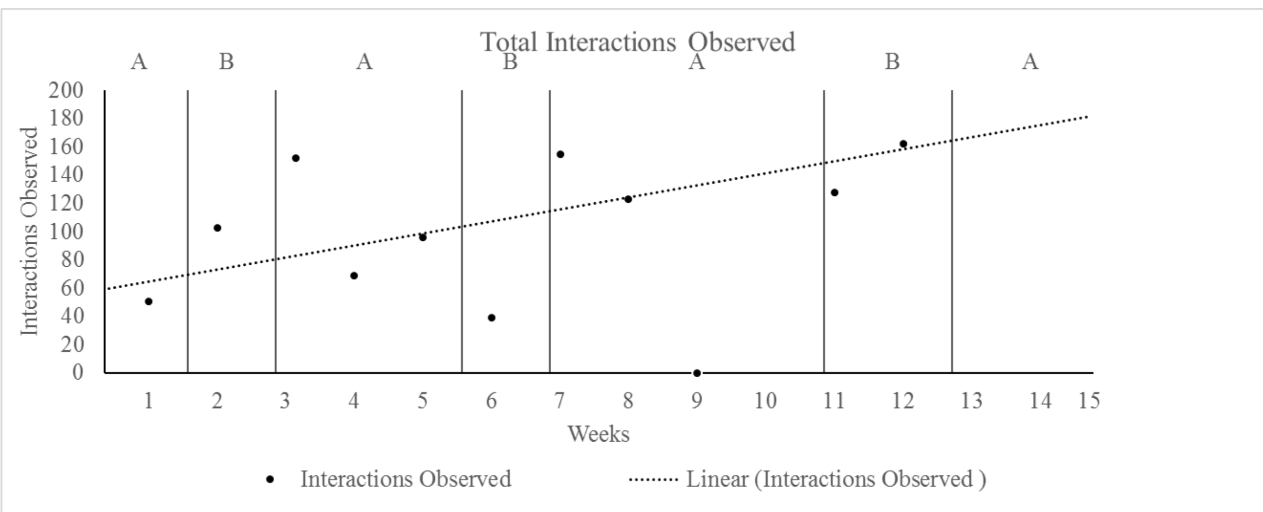



Figure 6. Weekly positive social interactions observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

Following implementation of gardening workshops, the total amount of positive social interactions was observed to be on a variable increasing trend. The percentage of positive social interactions were calculated by dividing the intervals in which an interaction was observed by the total number of intervals each participant attended the social hour. During the first ten weeks, there was at least one occurrence where zero positive social interactions occurred within each phase. During the last four weeks, the level ranged from five to eighty nine positive social interactions observed. The percentage of non-overlapping data points is equal to 23.1% when comparing the first baseline condition to the first intervention phase in Figure 5. The percentage of non-overlapping data decreased to 5.26% when comparing the second baseline condition to the second intervention phase. The amount of positive social interactions observed increased from baseline to intervention. This trend cannot be attributed exclusively to participation in the gardening workshops because a robust, systematic change in behavior was not observed between phases.

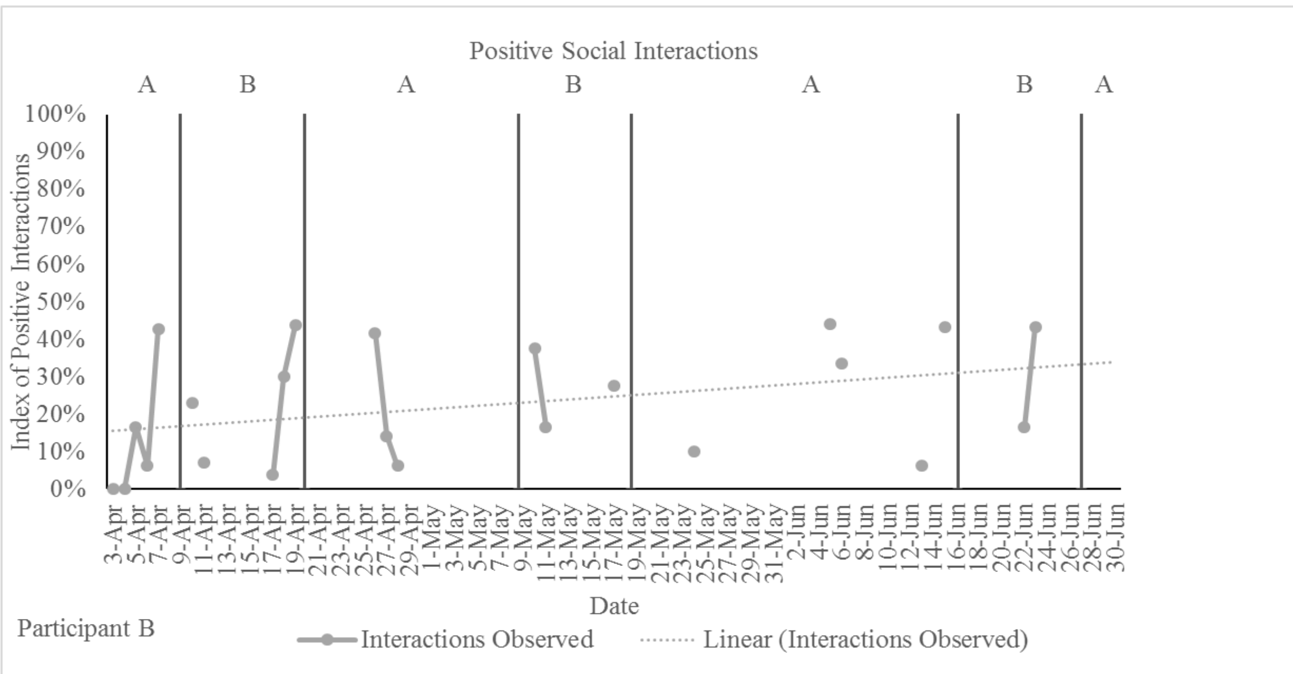



Figure 7. Daily positive social interactions of participant B observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

The average duration participant B interacted socially during the social hour within the initial baseline condition was 1 minute. During the first intervention phase, this participant engaged in positive social interactions an average of 30 seconds while they attended the social hour. Following the initial intervention, participant B engaged in positive social interactions an average of 1 minute during the social hour during the first return to baseline phase and the second intervention phase. During the third baseline condition, this participant spent an average of 2 minutes during the social hour interacting. During the final intervention phase, participant B engaged in positive social interactions during an average of 3 minutes during each social hour. Participant B did not attend any social hours during the final baseline phase, therefore no behavioral data was collected regarding participant B during this phase. There was an increasing trend and variable level between 6% and 42% in baseline, an accelerating slope and variable level between 3% and 43% during the first intervention phase, and a deaccelerating slope during the first return to baseline, with a variable level between 6% and 41% (Figure 7). The second intervention phase had a stable level between 16% and 37% and the second return to baseline phase had a variable level between 6% and 43%. The level was between 16% and 43% during the final intervention period and reached 30% during the final baseline phase.

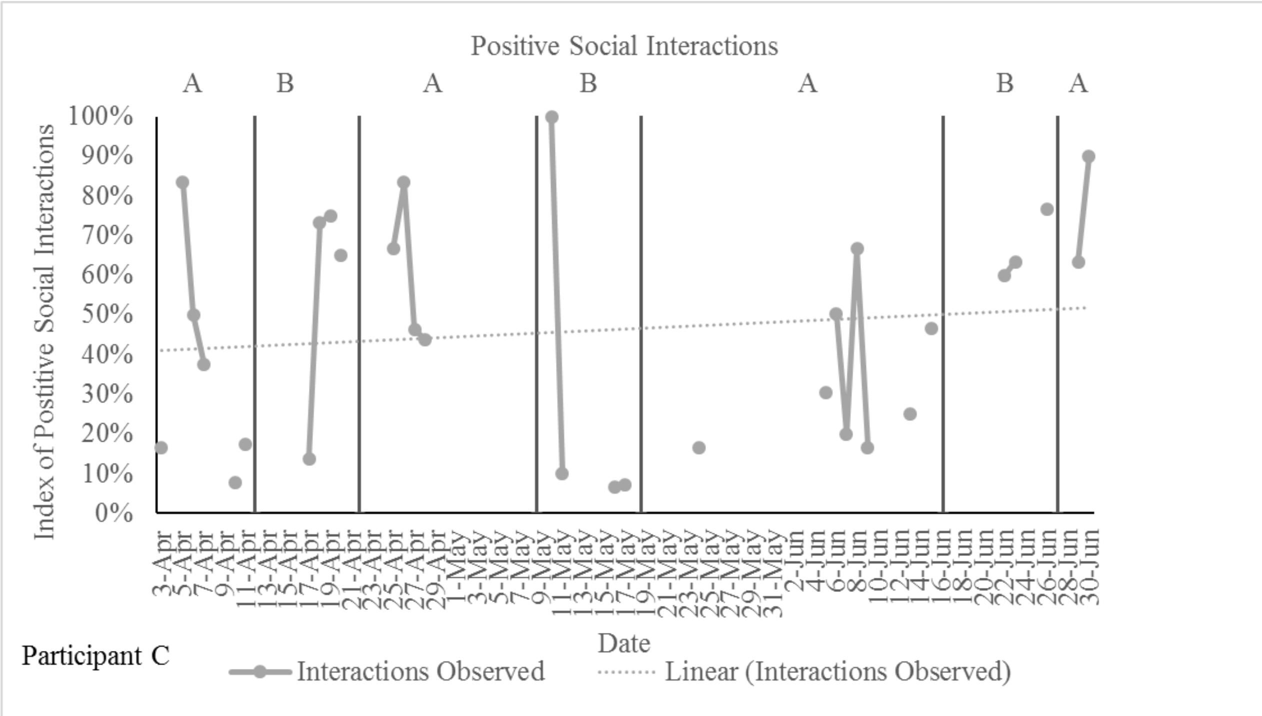



Figure 8. Daily positive social interactions of participant C observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

The average duration participant C interacted socially during the designated social hour in the initial baseline condition was 2 minutes. During the first intervention phase, this participant engaged in positive social interactions an average of 6 minutes each day during the designated social hour. Following the initial intervention, participant C engaged in positive social interactions during an average of 7 minutes while attending the social hour. During the second intervention phase, participant C engaged in positive social interactions for an average of less than 1 minute while attending the social hour. During the third baseline condition, this participant spent an average of 1 minute each day socializing during the designated social hour. During the final intervention and baseline phases, participant C spent an average of 12 minutes and 7 minutes respectively during the social hour. There was a decreasing trend and variable level between 16% and 83% of time spent interacting in baseline, an accelerating slope and variable level between 13% and 75% during the first intervention phase, and a deaccelerating slope during the first return to baseline, the second intervention phase and the second return to baseline phase (Figure 8). The level remained variable between 6% and 100% during the second intervention phase, and between 16% and 66% during the second return to baseline phase. The final intervention period and final return to baseline phase had increasing slopes. The final intervention period had a stable level between 60% and 76%.

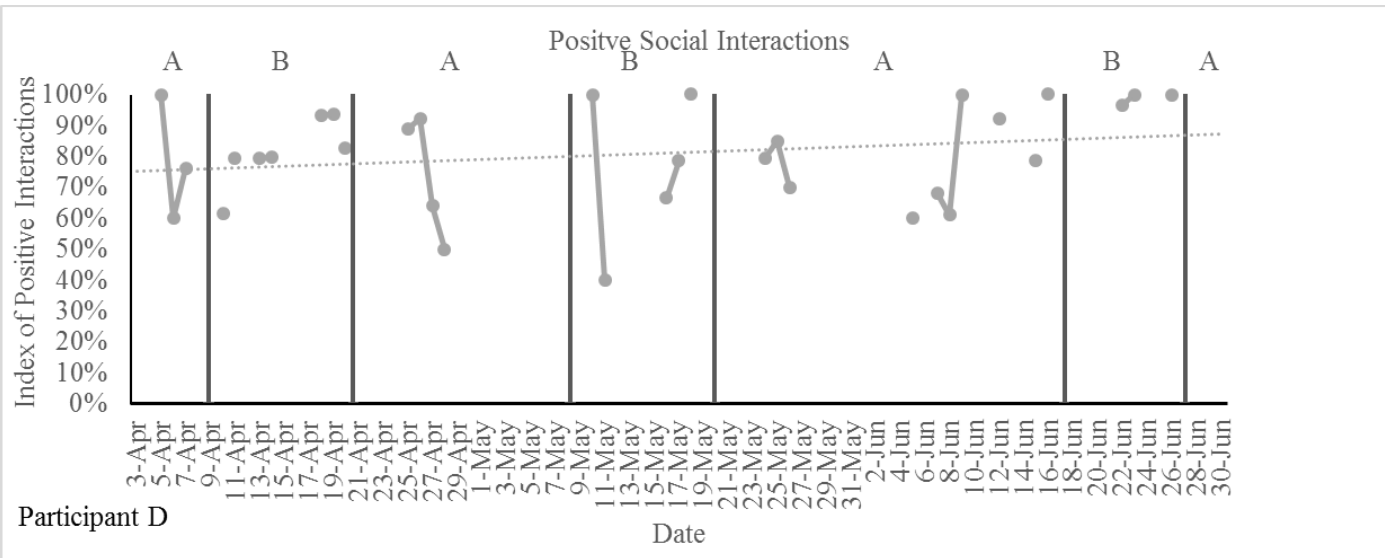



Figure 9. Daily positive social interactions of participant D observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

The average duration participant D spend engaged in positive social interactions during the social hour in the initial baseline condition was 8 minutes. During the first intervention phase, this participant engaged in positive social interactions an average of 16 minutes of each social hour. Following the initial intervention, participant D engaged in positive social interactions an average of 10 minutes of each social hour. During the second intervention phase, participant D engaged in positive social interactions for an average of 13 minutes of the social hours attended. During the third baseline condition, this participant spent an average of 14 minutes of the social hours attended interacting socially. During the final intervention phase, participant D engaged in positive social interactions during an average of 29 minutes while they attended the social hour. Participant D did not attend any social hour times during the final baseline phase, therefore no behavioral data was collected regarding participant D during this phase. There was a decreasing trend and stable level between 60% and 100% in the initial baseline phase, an accelerating slope and variable level between 61% and 80% during the first intervention phase, and a deaccelerating slope during the first return to baseline, with a variable level between 50% and 92% (Figure 9). The second intervention phase had an increasing trend and variable level between 40% and 100% and the second return to baseline phase had an increasing trend with a stable level between 60% and 100%. The level was stable between 96% and 100% during the final intervention period and reached 100% during the final baseline phase. Of the three participants that attended the social hour and greenhouse regularly, this participant was the most socially interactive during the initial baseline phase.

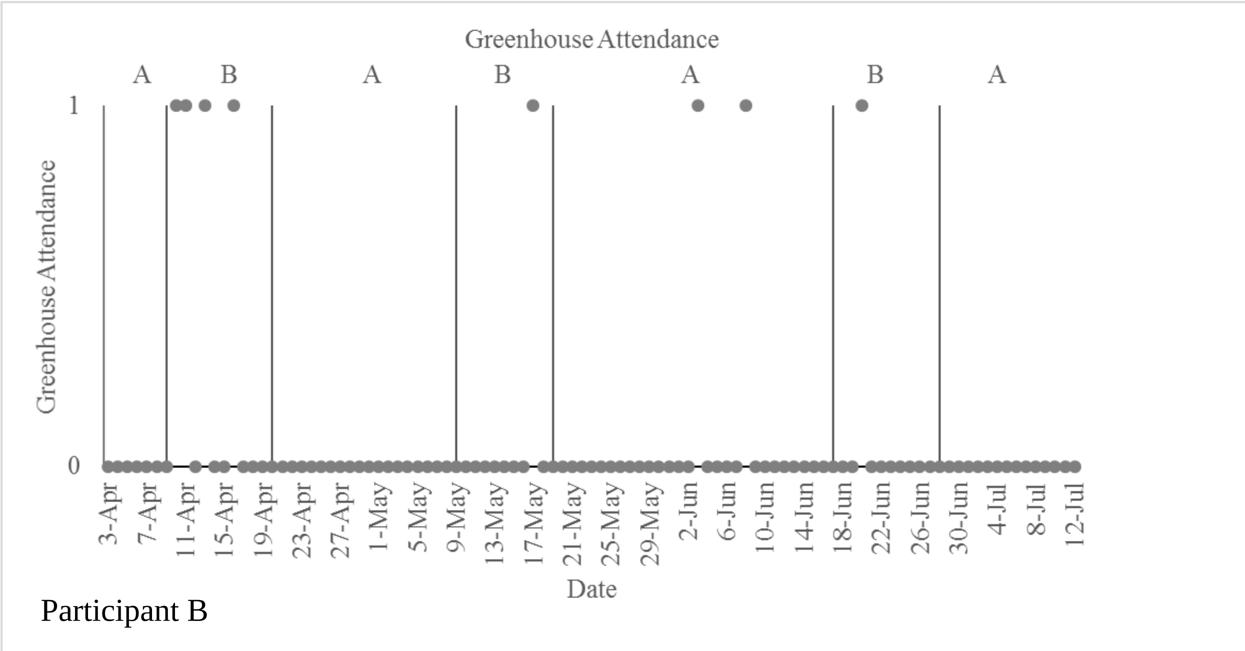



Figure 10. Daily greenhouse attendance of participant B observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

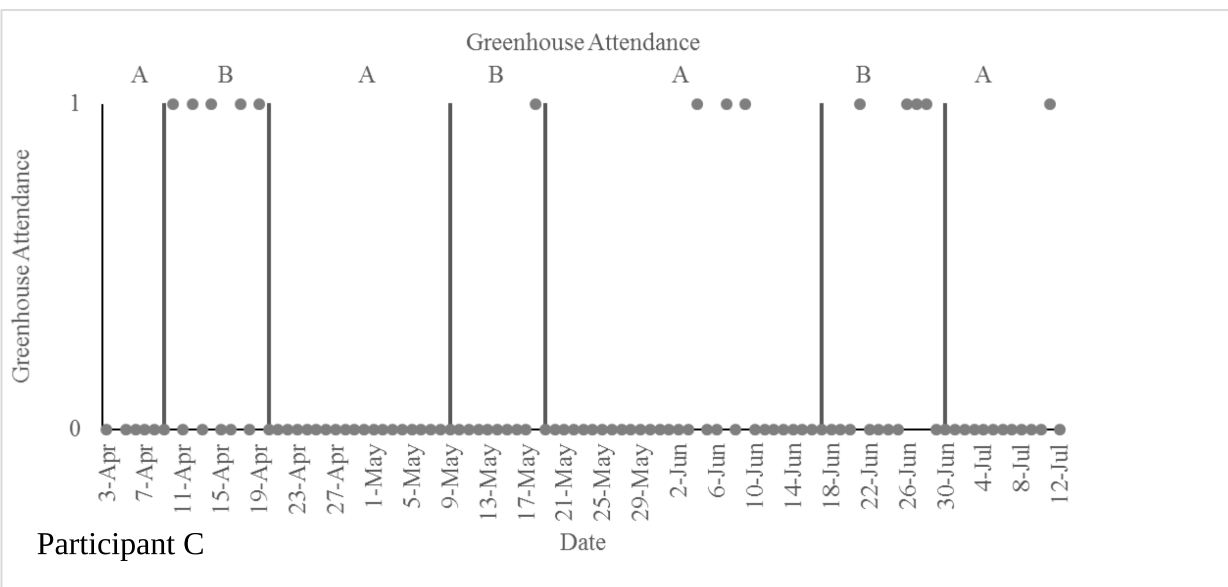



Figure 11. Daily greenhouse attendance of participant C observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

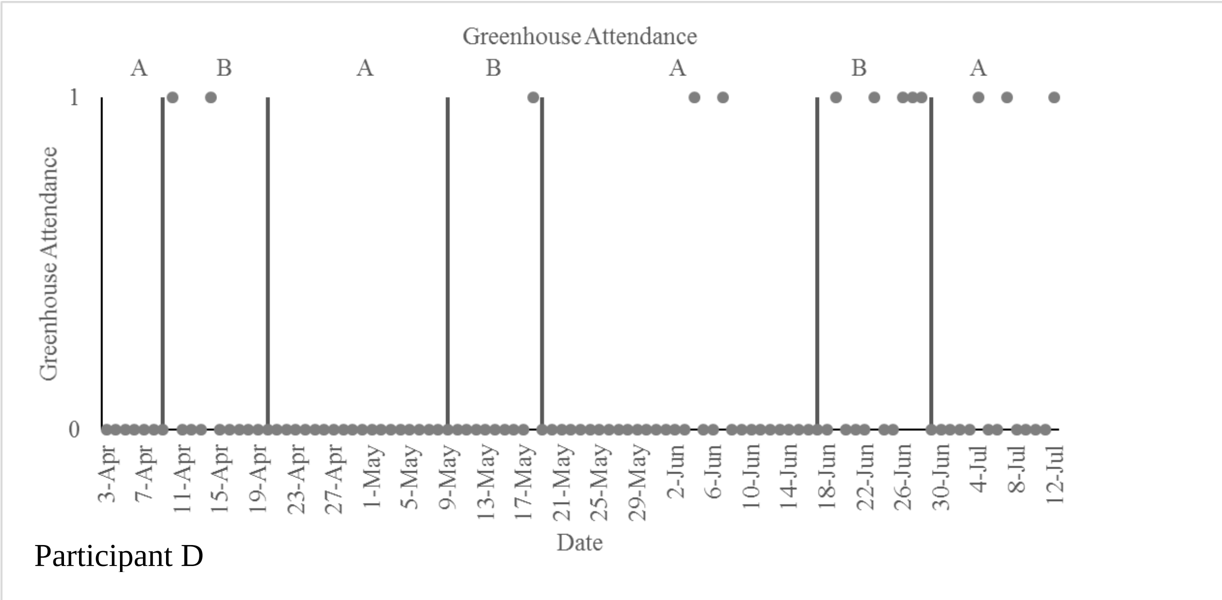



Figure 12. Daily greenhouse attendance of participant D observed before, during, and after implementation of the gardening workshop series. A represents a baseline condition during which no intervention was in place and the B represents the intervention period, during which participants engaged in gardening workshops.

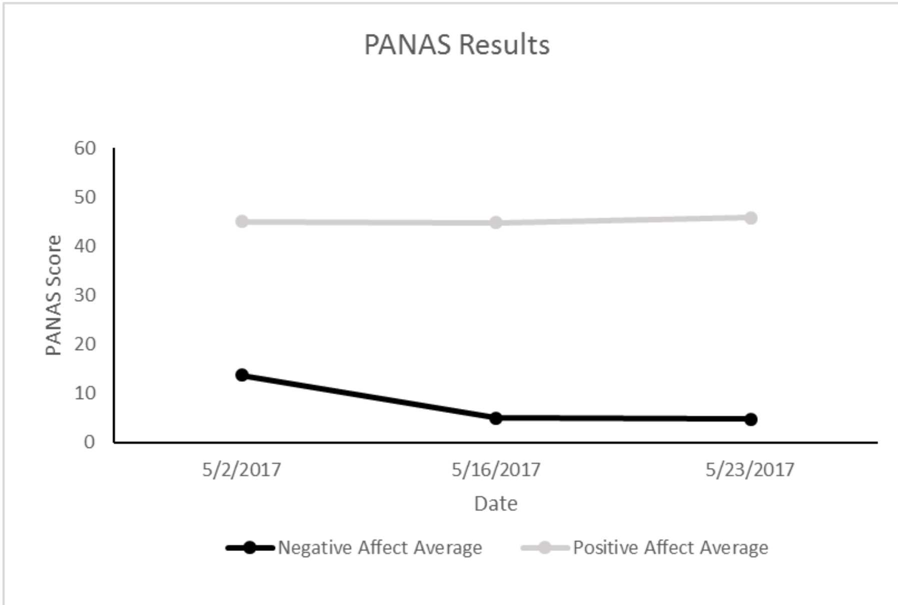



Figure 13. The positive and negative affect scale results collected from regular attendees of the workshops before, during, and after participation in the gardening workshops.

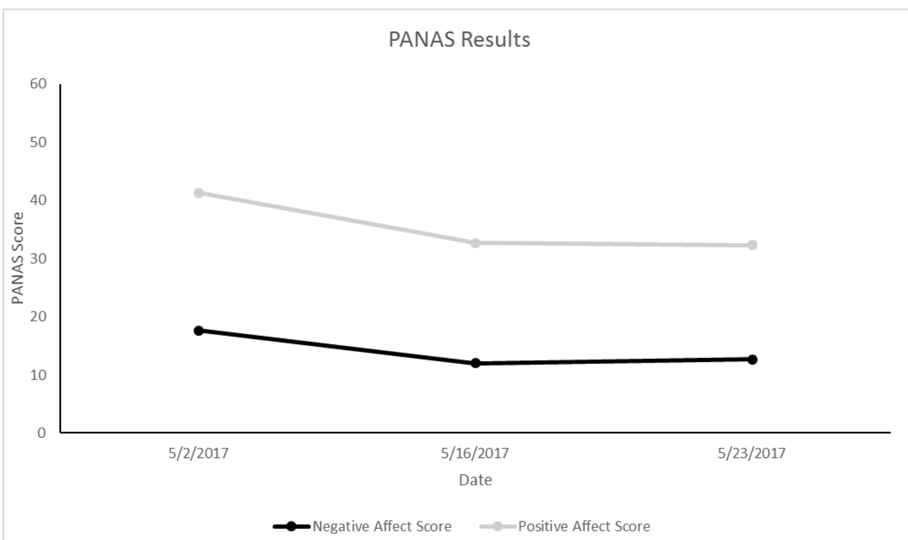



Figure 14. The positive and negative affect scale results collected from non-regular attendees of the workshops before, during, and after gardening workshops were offered.

Before implementation of the gardening workshops, the average positive affect scale score was 43.6. During the horticultural intervention, this number decreased to 38 for the group that did not participate in the workshops (n=5) and 43.5 in the group that attended the workshops regularly (n=2). After the workshop series, the mean positive affect scores were 44.5 in the group that attended the workshops regularly and 38.2 in the group that did not attend the workshops. Before implementation of the gardening workshops, the average negative affect scale score was 14.85. During the horticultural intervention, this number decreased to 5 in the group that attended the workshops regularly and 9.2 in the group that did not attend the workshops. There was a significant decrease in the negative affect scale scores in participants that attended the gardening workshops regularly reported after implementation of the intervention($t=2.746$, $df=10$, $p=.0496$). Figure 13 presents the positive and negative affect scale scores of participants that regularly attended the workshops before, during, and after implementation of the horticultural intervention. Figure 14 presents the positive and negative affect scale scores of participants that did not regularly attended the workshops before, during, and after implementation of the horticultural intervention. After the workshop series, the average negative affect score was 4 in the regular attendees group and 9.8 in the group that did not participate.

**Using Horticulture to Lower Stress in College Students**

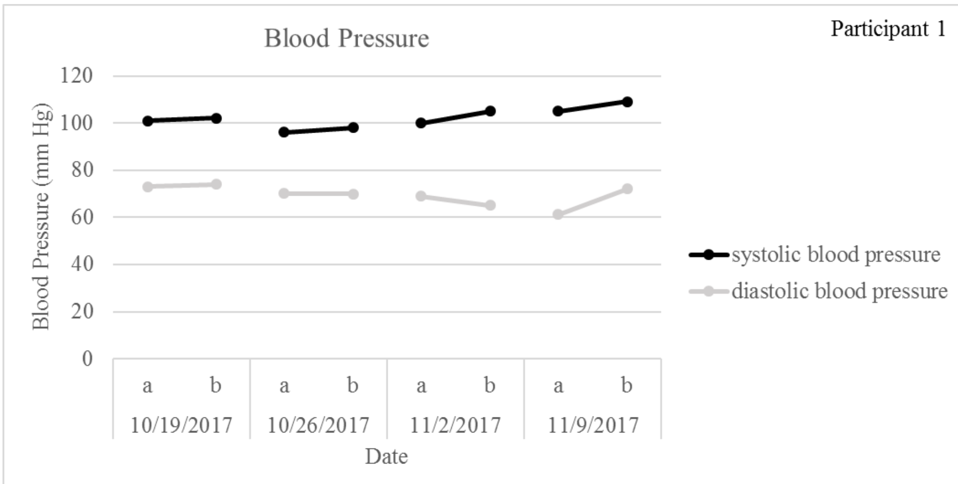



Figure 15. Blood pressure data collected from participant 1 before (a) and after (b) horticultural intervention.

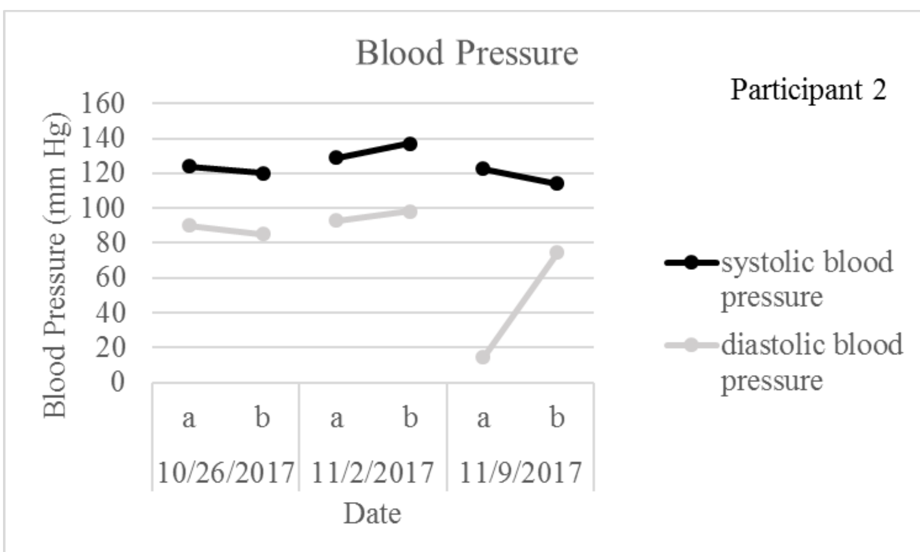



Figure 16. Blood pressure data collected from participant 2 before (a) and after (b) the horticultural intervention.

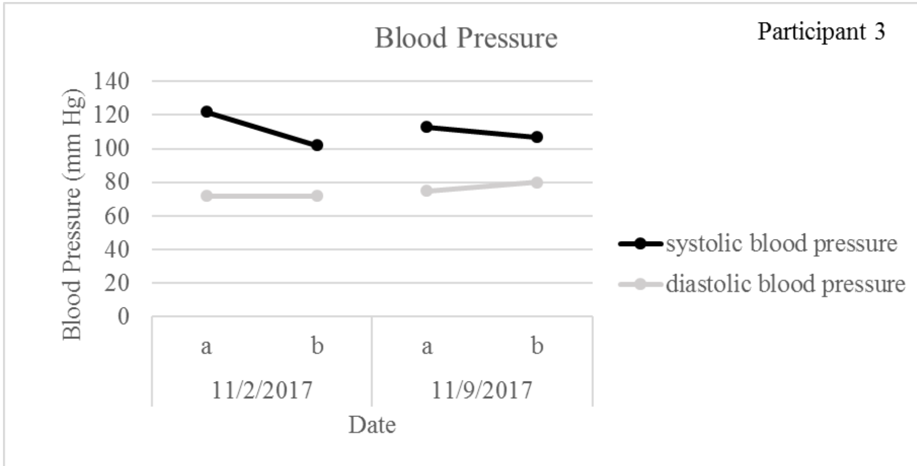



Figure 17. Blood pressure data collected from participant 3 before (a) and after (b) the horticultural intervention.

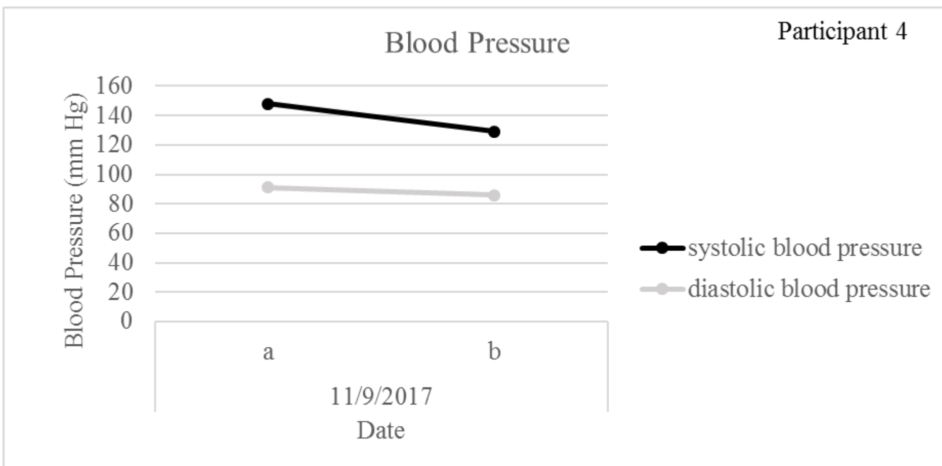



Figure 18. Blood pressure data collected from participant 6 before (a) and after (b) the horticultural intervention.

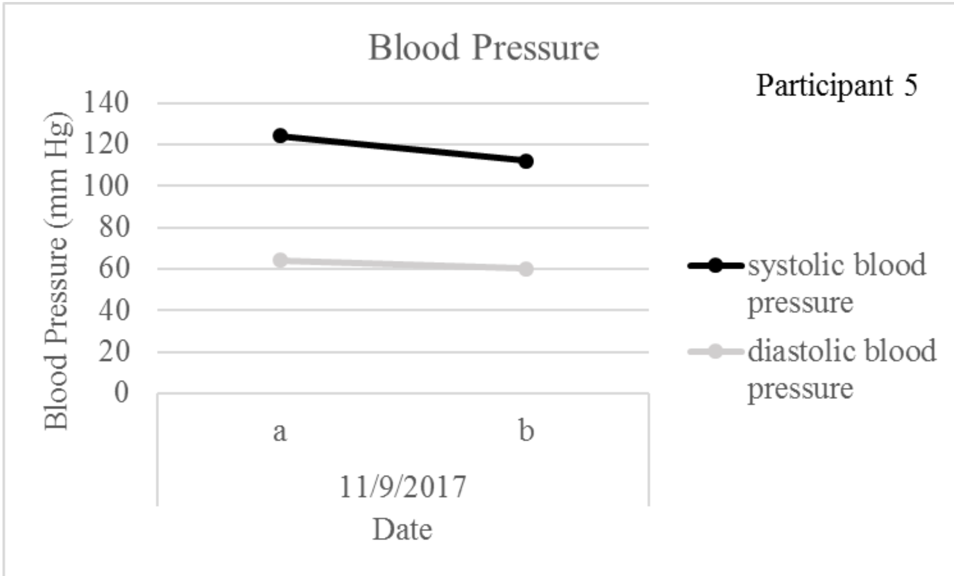



Figure 19. Blood pressure data collected from participant 5 before (a) and after (b) the horticultural intervention.

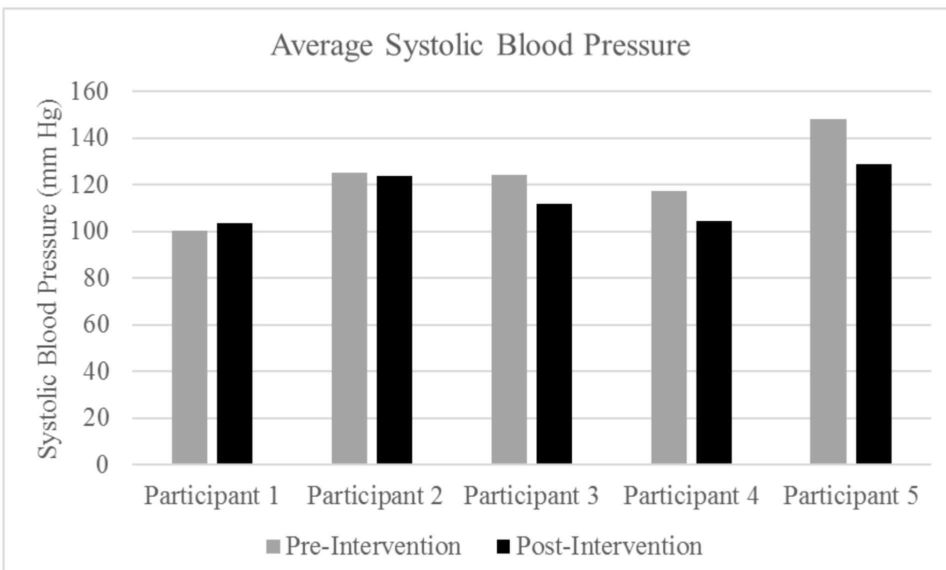



Figure 20. Average systolic blood pressure collected from participants before and after the horticultural intervention.

Before engagement in the horticultural intervention, the individual systolic blood pressure values ranged from 96 to 148 mm Hg, and the group average systolic blood pressure was 123 mm Hg. After engagement in the horticultural intervention, this value decreased to 114 mm Hg, and individual values ranged from 98 to 137 mm Hg. Post treatment systolic blood pressure was lower than pre-treatment systolic blood pressure measurements by 8.47 mm Hg ($t=2.10$, $df=4$, $p=0.0521$) (Table 5). Prior to engagement in the horticultural intervention, the individual diastolic blood pressure values ranged from 61 to 93 mm Hg, the group average diastolic blood pressure was 71.8 mm Hg. After engagement in the horticultural intervention, the group average increased to 72.80 mm Hg, individual diastolic blood pressure values ranged from 62 to 98 mm Hg. Post treatment diastolic blood pressure was higher than pre-treatment diastolic blood pressure measurements by 1.03 mm Hg, however this value was not statistically significant ($t=0.204$, $df=4$, $p=0.4239$) (Table 6).

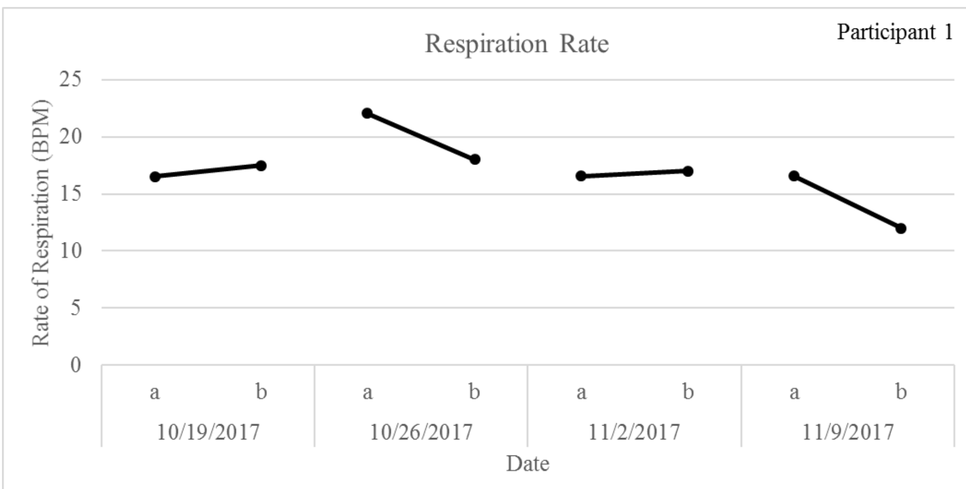



Figure 21. Respiration rate data collected from participant 1 before (a) and after (b) the horticultural intervention. Rate of respiration was measured in breathes per minute (BPM).

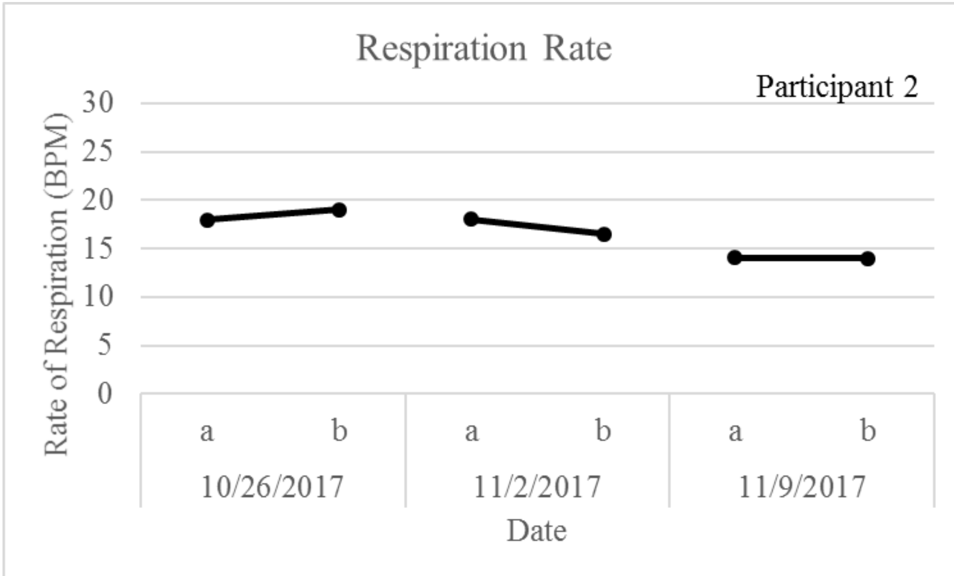



Figure 22. Respiration rate data collected from participant 2 before (a) and after (b) the horticultural intervention. Rate of respiration was measured in breathes per minute (BPM).

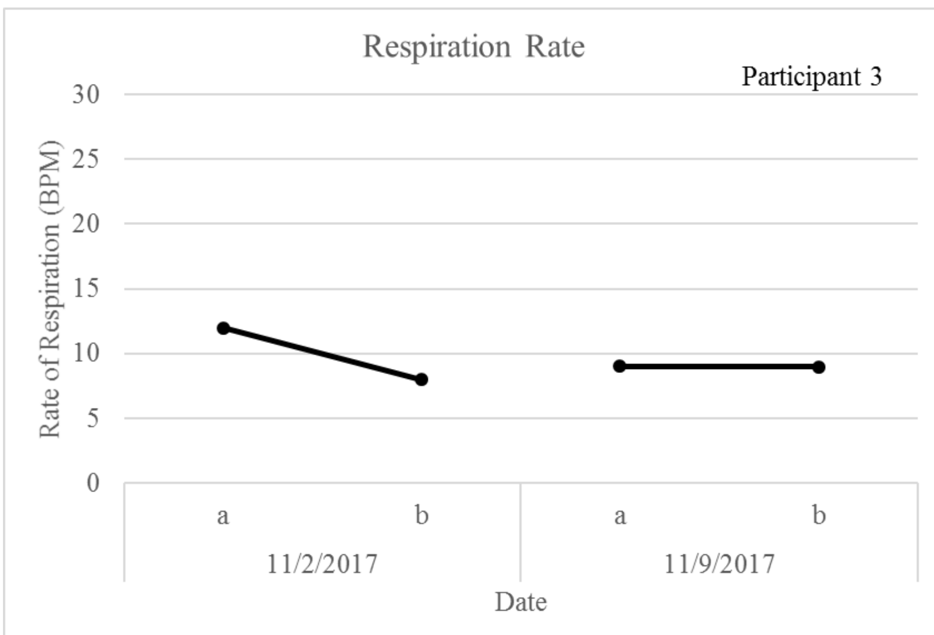



Figure 23. Respiration rate data collected from participant 3 before (a) and after (b) the horticultural intervention. Rate of respiration was measured in breathes per minute (BPM).

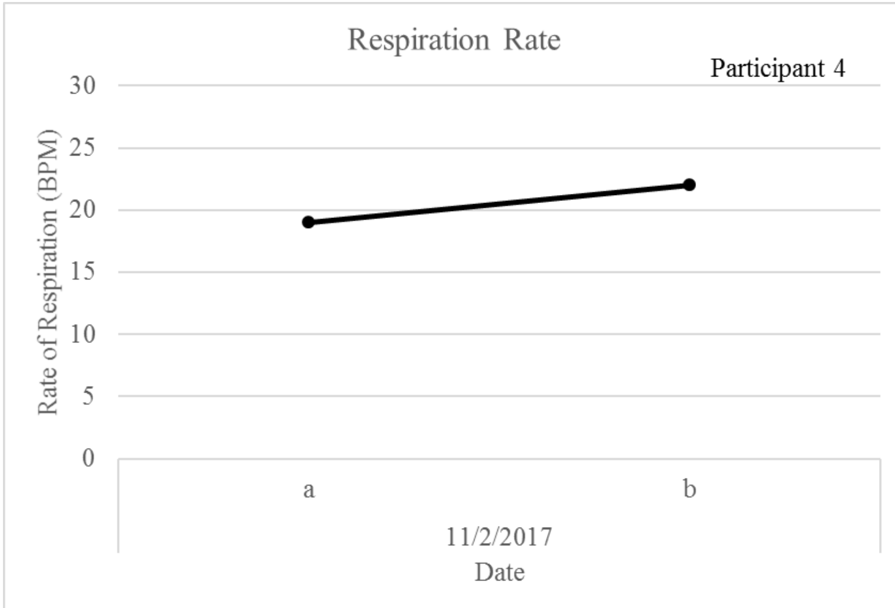



Figure 24. Respiration rate data collected from participant 4 before (a) and after (b) the horticultural intervention. Rate of respiration was measured in breathes per minute (BPM).

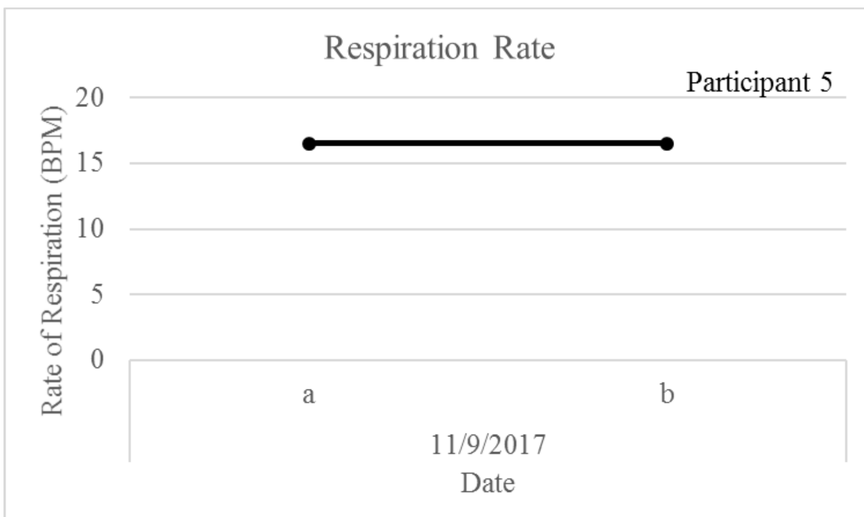



Figure 25. Respiration rate data collected from participant 5 before (a) and after (b) the horticultural intervention. Rate of respiration was measured in breathes per minute (BPM).

Before engagement in the horticultural intervention, the group average rate of respiration was 16.5 breaths per minute, with individual respiration rates ranging from 9 to 22. After engagement in the horticultural intervention, the individual values ranged from 8 to 33 and the group average rate of respiration value increased to 18.9 breaths per minute. The average body temperature increased from 36.83 degrees Celsius before horticultural intervention to 36.88 degrees Celsius after horticultural intervention (Table 6). The average pulse in beats per minute was equal to 68.5 before engagement in the horticultural intervention and 67 beats per minute after engagement ($t=0.28$, $df=4$, $p=0.395$) (Table 7). None of the participants reported feeling any pain before or after the intervention period, therefore self-reported pain was omitted from statistical analysis.

# DISCUSSION

## Limitations and Suggestions

The lack of attendance during the data collection period limited the research team to observe a small sample size during both projects. At the long-term care facility for older adults, behavioral data were only recorded during the designated social hour. Before the study began, the benefits of engaging in horticultural activities and the purpose of the study were disclosed to all participants in accordance with IRB (Institutional Review Board) protocol. Issues of self-selection and lack of blindness to the overall purpose of the study should be considered for future research. Concerns of costliness were unfounded in this study as a majority of the materials used during the gardening workshops were donated and greenhouse aids were recruited as volunteers. The donations of supplies and volunteer's time to this project suggest that similar methods can be employed at low cost. About one month after data collection began, the participants began to recognize the research team during the social hour, and the results may have been influenced by participants familiarizing with the research team as the study progressed. Recruitment of a staff member to aid in the collection of behavioral data is recommended for future studies. Most residents accessed the greenhouse by going outside, and adverse weather conditions most likely deterred participants from accessing the greenhouse. Longitudinal studies with longer intervention and baseline phases are suggested for future investigations in order to reduce seasonal variability within the data.

Some aspects of data collection on a college campus, such as having vital signs tests performed, may have caused anxiety and may have influenced the results. There is still a need for additional well-designed, controlled trials to help establish causality that the horticultural intervention caused an increase in positive social interactions and improved emotional affect rather than the passage of time or the change in weather. Future researchers should continue collecting baseline data until steady state responding is observed, then proceed to the intervention phase and coordinate with the staff to collect more direct measures of depression such as sleeping and dietary patterns. Interdisciplinary studies evaluating the soil microbial community and air quality in the greenhouse and their impact on more direct measures of depression are suggested.

**Conclusions**

This study aimed to quantitatively evaluate the effects of a horticultural intervention on two populations, older adults and college students. Implementation of gardening workshops increased greenhouse attendance, as evident by the robust increase in greenhouse attendance. Greenhouse attendance appeared to correlate with the gardening workshops during the first and second intervention periods. There was a change in weather during the latter half of the study (Table 1), which may have influenced residents to visit the greenhouse more often when workshops were not offered. Gardening workshops may be most effective in increasing greenhouse attendance during the colder months, when residents are unlikely to use the greenhouse unless there is an organized activity scheduled. During the latter half of the study, five residents that were not recruited to participate in the study attended every evening workshop that was offered. This increase in greenhouse attendance among non-participants suggests that the efforts to increase greenhouse attendance and awareness were successful throughout the home and not limited to participants of the study.

Results from the PANAS indicate a difference between the positive and negative affects reported by participants that regularly attended the gardening workshops compared to those who did not engage in the workshops. A linear mixed model controlling for within-subject variation revealed a statistically reliable difference between the negative affect scores of participants that attended the gardening workshops before and after participation in the workshops, $t(10)=2.746$, $p=0.0496$, $a=0.05$. Participants that engaged in 8 or more gardening workshops within a 12 week period reported decreased feelings of distress, irritability, nervousness, and fear (Figure 13).

The amount of positive social interactions increased from baseline to intervention for all participants that regularly attended the gardening workshops and the social hours (Figures 7, 8, & 9). The total amount of positive social interactions was observed to have a variable, increasing trend (Figure 5). This trend cannot be solely attributed to participation in the gardening workshops because a robust, systematic change in behavior was not observed between phases. Physiological data collected from college students before and after engaging in a horticultural intervention suggest lowered systolic blood pressure and heart rate after 30 minutes spent engaged in gardening activities (Figure 20 & Tables 5 & 6).

Statements regarding the workshop series from participants at the university and staff at the long-term care facility elicited positive feedback. From one staff member, “It (the gardening workshops) gives them (the residents) relief from stress, anxiety, depression, peace of mind, serenity, or even being able to accomplish something at their age. It is nice to see them smile while they plant seeds or prepare soil.”

The activity manager of the facility said, “They looked forward to the events that she had planned and the staff especially did too. It is a difficult task coordinating all of the events to include getting members to the green house but it was so worth the interactions and the smiles on the member’s faces when they participated. It brought several new ideas and information about different plants and techniques to the Home, even education on dirt and a salad to eat.”

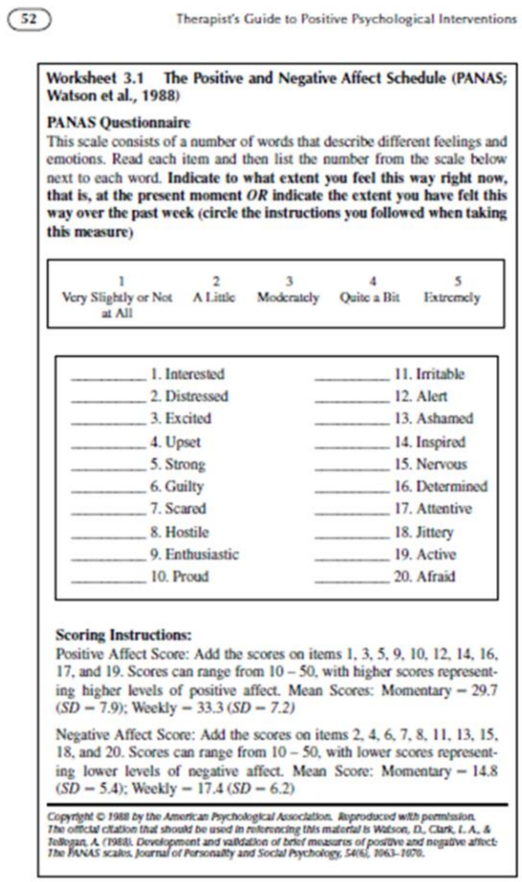
One student participant on gardening, “It makes you feel less stress and more relaxed. Greenhouses are great because they connect us with our environment, even in urban areas, where access to green space is limited.” Another student added, “Gardening keeps me focused on the task at hand. It’s nice to care for something and watch them (the plants) grow.”

As a result of the horticultural intervention, greenhouse attendance increased at a long-term care facility and feelings of distress, irritability, nervousness, and fear decreased for participants that attended the workshops regularly. The number of positive social interactions observed increased for all participants that regularly attended the gardening workshops (Figure 29). Physiological data collected from college students before and after engaging in horticultural interventions suggest a lowered systolic blood pressure after 30 minutes spent engaged in gardening activities (Figure 20).

**Implications**

The horticultural interventions that took place in a greenhouse provided physical contact with plants and soil. The plants and microorganisms within the greenhouse may have removed volatile organic compounds and increased air quality. The soil, along with amendments such as worm castings, may have contained microorganisms such as *Mycobacterium vaccae*, which has been reported to increase serotonin levels in animal experimental trials (Lowry et al., 2007). The biophilia hypothesis (Wilson, 1984) and psychophysiological stress reduction theory (Ulrich, 1991) provided the framework for an investigation of vital signs before and after gardening. A decrease in systolic blood pressure was observed in a small sample size, if similar results are found with a more diverse sample size, then that evidence may support Ulrich's notion that natural areas and green spaces allow psychophysiological stress recovery. The greenhouse environment facilitated social interaction, and attendees of the gardening workshops engaged in more positive social interactions and reported decreased negative affect compared to residents that did not regularly attend the workshops**.** This study presented quantitative behavioral and physiological evidence focused on the positive effects of horticultural intervention on holistic human health. Horticultural interventions could be used to improve the quality of life in older adults and reduce stress in college students. Additionally, horticultural interventions have been recognized as helpful in the reduction of pain (Ulrich, 1984). Horticultural interventions should be considered for implementation in hospitals and long-term care facilities as one approach to shorten hospitalization periods and as a potential alternative to addictive pain medications.

# Appendix A



52 Therapist's Guide to Positive Psychological Interventions

**Worksheet 3.1 The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988)**

**PANAS Questionnaire**

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment *OR* indicate the extent you have felt this way over the past week (circle the instructions you followed when taking this measure)**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Very Slightly or Not at All | A Little | Moderately | Quite a Bit | Extremely |

| | |
|---|---|
| __________ 1. Interested | __________ 11. Irritable |
| __________ 2. Distressed | __________ 12. Alert |
| __________ 3. Excited | __________ 13. Ashamed |
| __________ 4. Upset | __________ 14. Inspired |
| __________ 5. Strong | __________ 15. Nervous |
| __________ 6. Guilty | __________ 16. Determined |
| __________ 7. Scared | __________ 17. Attentive |
| __________ 8. Hostile | __________ 18. Jittery |
| __________ 9. Enthusiastic | __________ 19. Active |
| __________ 10. Proud | __________ 20. Afraid |

**Scoring Instructions:**

Positive Affect Score: Add the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Scores can range from 10 – 50, with higher scores representing higher levels of positive affect. Mean Scores: Momentary – 29.7 (*SD* – 7.9); Weekly – 33.3 (*SD – 7.2)*

Negative Affect Score: Add the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Scores can range from 10 – 50, with lower scores representing lower levels of negative affect. Mean Score: Momentary – 14.8 (*SD* – 5.4); Weekly – 17.4 (*SD* – 6.2)



Figure 26. The positive and negative affect scale (PANAS; Watson et al., 1988). The Positive and Negative Affect Schedule (PANAS) comprises two mood scales, one that measures positive affect and the other which measures negative affect.

Table 1. Average temperatures of each phase in Fahrenheit and Celsius.

| Phase | Date | Average Outdoor Temperature (ºF) | Average Outdoor Temperature (ºC) |
|---|---|---|---|
| A | 4/3-4/9 | 41.7 | 5.4 |
| B | 4/10-4/19 | 37.1 | 2.8 |
| A | 4/20-5/7 | 39.8 | 4.3 |
| B | 5/8-5/18 | 48.8 | 9.3 |
| A | 5/19-6/15 | 56.2 | 13.4 |
| B | 6/16-6/28 | 58.5 | 14.7 |
| A | 6/28-7/12 | 62.1 | 16.7 |

Figure 27. The long-term care facility's greenhouse before and after implementation of a gardening workshop series.

Figure 28. The long term care facility's greenhouse. The greenhouse is wheelchair accessible and there are 3 raised garden beds adjacent to the greenhouse.

Table 2. Plants that were grown and maintained during the workshop series.

| | |
|---|---|
| Ornamental house plants | Guiana Chestnut Tree (*Pachira aquatic*), Sword Ferns (*Nephrolepis exaltata*), Geranium (*Pelargonium hortorum*), Spider plant (*Chlorophytum comosum*), Mother in Law's Tounge (*Sansevieria trifasciata*) |
| Vegetables | Lettuce (*Lactuca sativa*), Spinach (*Spinacia oleracea*), Kale (*Brassica oleracea var. sabellica*), Swiss Chard (*Beta vulgaris subsp. vulgaris*), Sugar Snap Peas (*Pisum sativum*), Carrots (*Daucus carota subsp. sativus*), Sweet Corn (*Zea mays*), |
| Herbs | Rosemary (*Rosmarinus officinalis*), Oregano (*Origanum vulgare*), Basil (*Ocimum basilicum*), Thyme (*Thymus vulgaris*), Sage (*Salvia officinalis*), Parsley (*Petroselinum crispum*) |
| Fruit | Strawberries (*Fragaria ananassa Duchesne*) Raspberries (*Rubus idaeus*), Tomato (*Solanum lycopersicu*) |
| Succulents | Mother of Thousands (*Bryophyllulm daigremontiana*), Aloe (*Aloe vera*), Donkey's tail (*Sedum morganianum*), Jade (*Crassula ovata*) |

Table 3. Results of a paired T-test comparing average systolic blood pressure before (A) and after (B) engaging in horticultural intervention.

| | *A* | *B* |
|---|---|---|
| Mean | 123 | 114.5333 |
| Variance | 291.625 | 130.3806 |
| Observations | 5 | 5 |
| Pearson Correlation | 0.872895 | |
| Hypothesized Mean Difference | 0 | |
| df | 4 | |
| t Stat | 2.095955 | |
| P(T<=t) one-tail | 0.052064 | |
| t Critical one-tail | 2.131847 | |
| P(T<=t) two-tail | 0.104128 | |
| t Critical two-tail | 2.776445 | |

Table 4. Results of a paired T-test comparing average diastolic blood pressure before (A) and after (B) engaging in horticultural intervention.

| | *A* | *B* |
|---|---|---|
| Mean | 71.78333 | 72.81667 |
| Variance | 120.7347 | 157.7722 |
| Observations | 5 | 5 |
| Pearson Correlation | 0.546739 | |
| Hypothesized Mean Difference | 0 | |
| df | 4 | |
| t Stat | -0.20456 | |
| P(T<=t) one-tail | 0.423952 | |
| t Critical one-tail | 2.131847 | |
| P(T<=t) two-tail | 0.847904 | |
| t Critical two-tail | 2.776445 | |

Table 5. Results of a paired T-test comparing average respiratory rate before (A) and after (B) engaging in horticultural intervention.

| | *A* | *B* |
|---|---|---|
| Mean | 16.466 | 18.85 |
| Variance | 11.96078 | 5.3 |
| Observations | 5 | 5 |
| Pearson Correlation | -0.19297 | |
| Hypothesized Mean Difference | 0 | |
| df | 4 | |
| t Stat | -1.18218 | |
| P(T<=t) one-tail | 0.151304 | |
| t Critical one-tail | 2.131847 | |
| P(T<=t) two-tail | 0.302607 | |
| t Critical two-tail | 2.776445 | |

Table 6. Results of a paired T-test comparing average body temperature before (A) and after (B) engaging in horticultural intervention.

| | *A* | *B* |
|---|---|---|
| Mean | 98.331 | 98.43 |
| Variance | 0.146805 | 0.146062 |
| Observations | 5 | 5 |
| Pearson Correlation | 0.719568 | |
| Hypothesized Mean Difference | 0 | |
| df | 4 | |
| t Stat | -0.77245 | |
| P(T<=t) one-tail | 0.241477 | |
| t Critical one-tail | 2.131847 | |
| P(T<=t) two-tail | 0.482955 | |
| t Critical two-tail | 2.776445 | |

Table 7. Results of a paired T-test comparing average pulse in beats per minute before (A) and after (B) engaging in horticultural intervention.

| | *A* | *B* |
|---|---|---|
| Mean | 68.5 | 66.95 |
| Variance | 11.25 | 107.2 |
| Observations | 5 | 5 |
| Pearson Correlation | -0.43463 | |
| Hypothesized Mean Difference | 0 | |
| df | 4 | |
| t Stat | 0.284284 | |
| P(T<=t) one-tail | 0.395151 | |
| t Critical one-tail | 2.131847 | |
| P(T<=t) two-tail | 0.790302 | |
| t Critical two-tail | 2.776445 | |

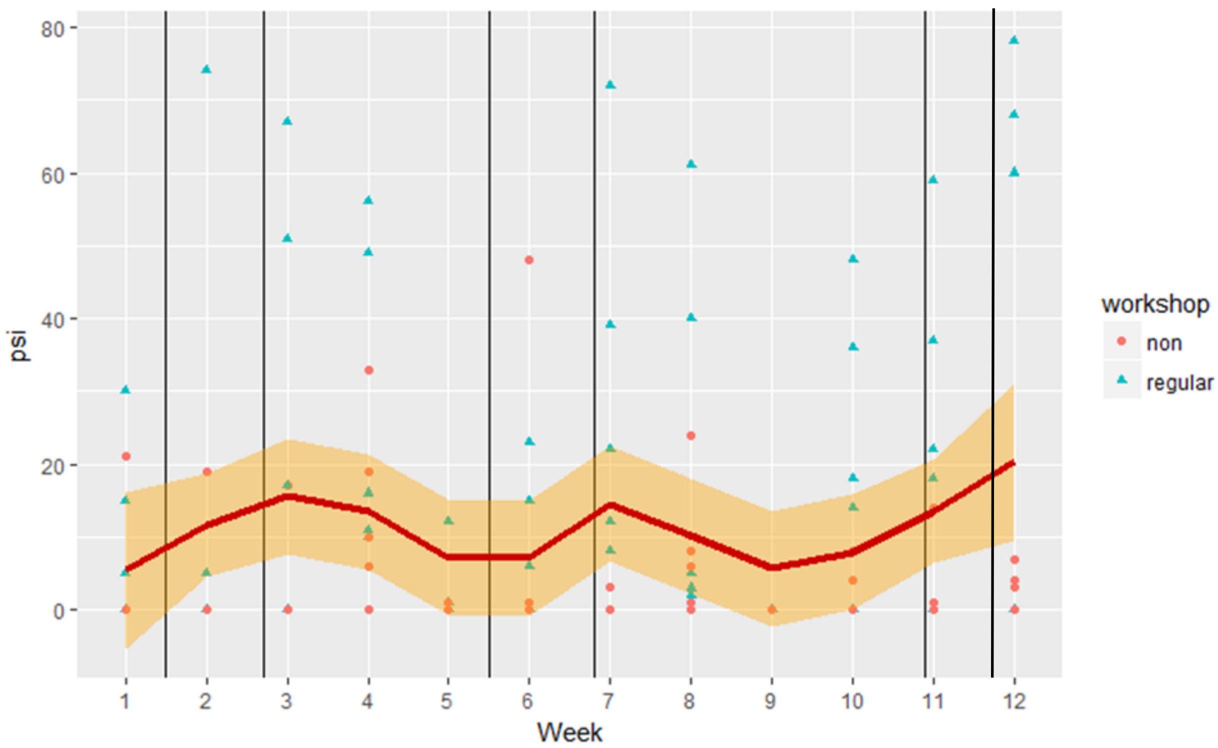



Figure 29. Individual positive social interactions observed by week. The red line represents the general trend, within a 95% confidence interval, represented by the orange coloration. The triangles represent participants that regularly attended the gardening workshops, and the circles represent participants that did not attend the gardening workshops.

## Appendix B

IRB Proposal HS17-823

IRB Approval Dates: 2/8/2017 - 2/8/2018

Proposed Project Dates: 4/1/2017 - 5/31/2017

"An evaluation of a therapeutic garden's influence on the behavior of veteran's home residents"

IRB Proposal HS17-885

IRB Approval Dates: 10/10/2017-10/10/2018

Proposed Project Dates: 9/25/2017-9/25/2018

“An evaluation of vital signs before and after gardening”

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